Claims

1. A force reflecting haptic interface including at least three degrees of freedom and a user interface, the user interface comprising:

a nose section; and

a user connection section detachably coupled to the nose section, the nose section interchangeable with alternative user connection sections.

2. The force reflecting haptic interface of claim 1, wherein the user connection section is selected from the group consisting of a stylus, a pistol grip, a roller ball, a mouse, a joystick, and a steering device.

3. The force reflecting haptic interface of claim of 1, wherein the user connection section couples to the nose section by a jack and chuck arrangement.

4. The force reflecting haptic interface of claim 1, wherein the user connection section decouples from the nose section upon application of a load greater than a threshold load value.

5. The force reflecting haptic interface of claim 1, wherein the user interface further comprises a first user input.

6. The force reflecting haptic interface of claim 5, wherein the user interface further comprises a second user input.

7. The force reflecting haptic interface of claim 6, wherein at least one of the first user input and the second user input is customizable by a user.

8. The force reflecting haptic interface of claim 6, wherein at least one of the first user input and the second user input comprises a switch.

9. The force reflecting haptic interface of claim 6, wherein at least one of the first user input and the second user input modifies a function of the user interface.

10. The force reflecting haptic interface of claim 9, wherein the user interface is adapted to function as a force feedback device and a computer mouse.

11. The force reflecting haptic interface of claim 10, wherein the user interface is adapted to function as a digitizer.

12. The force reflecting haptic interface of claim 1, wherein the user interface comprises a housing, the housing comprising multiple components that interlock without requiring a fastener.

13. The force reflecting haptic interface of claim 1 further comprising a yoke assembly coupled to the nose section.

14. The force reflecting haptic interface of claim 13, wherein the yoke assembly comprises two hinged halves adapted to capture a pair of projections extending from the nose section.

15. The force reflecting haptic interface of claim 14, wherein each projection is adapted to mate with a bearing and at least one of the projections is adapted to mate with a sensor for outputting a signal representative of a position of the user interface relative to the yoke assembly.

16. The force reflecting haptic interface of claim 1, wherein the user interface includes a sensor for outputting a signal representative of a position of the user connection section relative to the nose section.

17. The force reflecting haptic interface of claim 1, wherein the user interface comprises a docking station.

18. The force reflecting haptic interface of claim 17, wherein the docking station comprises a projection disposed on one of the user interface and a housing of the haptic interface and a mating recess formed in the other of the user interface and the housing.

19. The force reflecting haptic interface of claim 18, wherein the docking station further comprises a sensor for indicating mating of the projection in the recess.

20. A force reflecting haptic interface, comprising:

at least three degrees of freedom; and

a multiple use user interface, the user interface adapted to support a first function and a second function.

21. The force reflecting haptic interface of claim 20, wherein the user interface is further adapted to support a third function.

22. The force reflecting haptic interface of claim 20, wherein the first function comprises a force feedback device.

23. The force reflecting haptic interface of claim 20, wherein the second function comprises a computer mouse.

24. The force reflecting haptic interface of claim 21, wherein the third function comprises a digitizer.

25. The force reflecting haptic interface of claim 20, wherein the user interface is switchable between the first function and the second function.

26. The force reflecting haptic interface of claim 21, wherein the third function is enabled independently from the first function and the second function.

27. A docking station for a force reflecting haptic interface including a housing and a user interface, the docking station comprising:

a mating structure; and

a switch disposed proximate the mating structure.

28. The docking station of claim 27, wherein the mating structure comprises a receptacle formed in the housing.

29. The docking station of claim 28, wherein the switch is actuatable by insertion of at least a portion of the user interface into the receptacle.

30. The docking station of claim 29, wherein, upon actuation of the switch, the haptic interface is set to a home position.

31. The docking station of claim 27 further comprising a retainer for retaining the user interface in the docking station.

32. The docking station of claim 31, wherein the retainer comprises:

a spring loaded projection disposed on one of the user interface and the docking station; and

a mating recess for receiving the projection disposed on the other of the user interface and the docking station.

33. The docking station of claim 27 further comprising an indicator.

34. The docking station of claim 33, wherein the indicator comprises a visual indicator.

35. The docking station of claim 33, wherein the indicator indicates at least one of a fault condition and a status.

36. A force reflecting haptic interface including at least three degrees of freedom, the haptic interface comprising:

a direct drive assembly comprising a first actuator for driving a first rotary element; and

a coaxial transfer drive assembly comprising a second actuator for driving a second rotary element, wherein the direct drive assembly and the transfer drive assembly are disposed on opposite sides of at least one of the first rotary element and the second rotary element.

37. The force reflecting haptic interface of claim 36, wherein the direct drive assembly and the transfer drive assembly each comprise a rotary element, the respective rotary elements disposed in an opposed coaxial configuration.

38. The force reflecting haptic interface of claim 36 further comprising a reflective encoder disposed on one end of at least one of the first actuator and the second actuator.

39. The force reflecting haptic interface of claim 36 further comprising a threaded capstan disposed on a shaft of at least one of the first actuator and the second actuator.

40. The force reflecting haptic interface of claim 36 further comprising a base for housing electrical components.

41. The force reflecting haptic interface of claim 40, wherein the base comprises ballast to at least partially offset forces arising during use of the haptic interface.

42. The force reflecting haptic interface of claim 41, wherein the ballast comprises a plurality of plates.

43 The force reflecting haptic interface of claim 36 further comprising an electrical interface in accordance with IEEE 1394.

44. The force reflecting haptic interface of claim 36, further comprising an external non-structural housing.

45. The force reflecting haptic interface of claim 44, wherein the housing comprises two halves mounted in opposition on a shaft passing through an axis of rotation of a rotary element.

46. The force reflecting haptic interface of claim 36 further comprising means for balancing at least one cantilevered rotary element without requiring a counterweight.

47. The force reflecting haptic interface of claim 46, wherein the balancing means comprises a torsion spring disposed about an axis of rotation of the rotary element.

48. A force reflecting haptic interface comprising at least three degrees of freedom and an internal temperature monitoring system without requiring a temperature sensor.

49. The force reflecting haptic interface of claim 48, wherein the temperature monitoring system comprises means for measuring duration and magnitude of current drawn by an actuator powering at least one of the degrees of freedom.

50. The force reflecting haptic interface of claim 49, wherein the system calculates a temperature inside the interface based on the measured duration and magnitude.

51. The force reflecting haptic interface of claim 50, wherein the system disables at least a portion of the interface if the calculated temperature exceeds a threshold temperature value.

52. A method of monitoring an internal temperature of a force reflecting haptic interface, comprising the steps of:

measuring magnitude of current drawn by an actuator within the interface;

measuring duration of the current drawn; and

calculating a temperature based upon the magnitude and duration measurements.

53. The method of claim 52 further comprising the step of disabling at least a portion of the interface if the calculated temperature exceeds a threshold temperature value.